

REMARKS

Information Disclosure Statement

The Examiner stated that the IDS filed on October 17, 2001 did not comply with Rule 98(a)(2), which requires a legible copy of each cited reference. Applicant filed a single IDS in the application on February 20, 2002 disclosing only U.S. No. 6,331,713 to Smick et al. Since Smick et al. has been cited by the Examiner, the issue is now moot.

A. Allowable Subject Matter

Applicants thank the Examiner for indicating that claims 5, 7-9, 14-17, 25, and 27-31 include allowable subject matter and would be allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims.

B. Prior Art Rejections

Claims 1-4, 6, 12, 13, and 18-22 stand rejected under 35 USC 102(a) as anticipated by U.S. Pat. No. 6,331,713 to Smick et al. ("Smick").

Claims 1 recite a focused ion beam column including an ion gun using a liquid metal ion source. A liquid metal source typically includes a needle-like tungsten emitter coated with gallium and heated to a high temperature. The emitter surface of the liquid metal ion sources is sensitive to contamination and, after exposure to the atmosphere, requires a start-up period to remove gases adsorbed onto the emitter surface.

Smick, on the other hand, describes a plasma-type ion source assembly for use in an ion implanter. Because the ions are not emitted from a solid surface, the plasma-type source of Smick is not as sensitive to atmospheric contamination when the system chamber is opened to insert or remove a work piece. Smick therefore makes no provision for isolating the source elements from the rest of the vacuum chamber.

Amended claim 1 recites "one or more dielectric bushings for positioning one or more lens elements and for providing a sealable vacuum container for the one or more elements, the interior of the vacuum container being vacuum selectively isolatable from the environment in the system vacuum chamber." Smick's dielectric bushing is not

sealable from the system vacuum chamber and does not form a vacuum container within a system chamber. Similarly, claim 18 recites a "dielectric bushing . . . formed to support and align multiple ion optical elements and to form a vacuum chamber surrounding those elements." The method of claim 23 includes a dielectric housing configured to form a sealable vacuum container for the gun and claim 26 recites "dielectric bushing for supporting one or more gun elements and for providing a gun vacuum container for the one or more gun elements."

Liquid metal ion sources are high brightness sources. The ions are emitted from a small surface area, and the beam can be focused to a sub-micron spot. Because of their high resolution, FIB systems with liquid metal ion sources are suitable for micromachining. To achieve a very small beam with minimal aberration, the optical elements must be precisely aligned.

Smick's ion implanter irradiates a relatively large area on the target compared to the beam spot of a focused liquid metal ion source. Because the beam is not focused to a sub-micron scale spot, the alignment of components is not as critical.

Claim 12 recites an "emitter assembly including pre-aligned liquid metal ion emitter, a suppressor, an extractor and an extractor aperture." The plasma ion source of Smick does not have an emitter. Moreover, Smick's electrodes 80 and 90 appear to be separated from housing 70 by shield 160 and so do not appear to be part of a pre-aligned assembly. Similarly, claim 19 recites an emitter assembly including an emitter, suppressor, and extractor being positioned and aligned with respect to each other, the assembly capable of being inserted as a unit into an ion beam optical column.

Claims 10 and 11 stand rejected under 35 USC 103(a) for obviousness over Smick in view of U.S. Pat. No 6,300,628 to Fujii et al. ("Fujii"). The Examiner states that Fujii discloses an FIB column that comprises an in-vacuum aperture changing mechanism and cites col. 2, lines 56-67 and col. 3, lines 1-9. Applicants submit that although Fujii's aperture strip itself is contained within the vacuum chamber, the aperture changing mechanism, that is, the mechanism that moves different ones of the apertures into the beam path, is located outside the vacuum chamber. This is shown in Fujii's

FIG. 2. The "penetration hole switcher device 10" is shown outside of "charged particle optical system 9," along with power supplies 22, 23, and 24 and control unit 25.

New claim 32 makes this relationship even clearer and recites "the in-vacuum aperture changing mechanism comprises a drive mechanism that is contained within the system vacuum chamber, thereby eliminating the requirement for a mechanical feedthrough to change the aperture."

Claims 23 and 26 stand rejected under 35 USC 103(a) for obviousness over Smick in view of U.S. Pat. No 6,348,689 to Koyama et al (Koyama I). Neither Koyama I nor Smick teaches a "dielectric housing configured to support multiple gun elements and to form a sealable vacuum container for the gun." Koyama I does not state that his housing 4 is made of a dielectric material. Koyama I shows all the optical elements not touching housing 4, so it would appear that housing 4 may be metallic.

Claims 24 stands rejected under 35 USC 103(a) for obviousness over Smick in view of U.S. Pat. No 6,365,905 to Koyama et al. (Koyama II) Koyama II. Applicant submits that claim 24 should be allowed for the reasons described above with respect to it parent claim 23.

C. New Claims 35-37

The Examiner states that no prior art was found disclosing an in-vacuum isolation valve mechanism. New claim 35 recites "a FIB column including a system vacuum chamber; an ion gun including a liquid metal ion source; a plurality of lens elements for extracting and focusing the ions, one or more beam apertures; and an electrostatic deflection means, the improvement comprising an in-vacuum for isolating the ion gun from the system vacuum chamber, the in-vacuum isolation valve having no mechanical linkage from the valve to the outside of the system vacuum chamber."

Applicants submit that claim 35-37 is therefore allowable.

D. Conclusion

Claims 1-37 are pending and believed to be allowable. Accordingly, a Notice of Allowance is respectfully requested. The Examiner is encouraged to contact the undersigned representative if should she have any questions or concerns.

Respectfully submitted,

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